PATENT SPECIFICATION

Convention Date (United States): May 26, 1930. **372,961**

Application Date (in United Kingdom): May 26, 1931. No. 15,427/31.

Complete Accepted: May 19, 1932.

COMPLETE SPECIFICATION.

Improvements in or relating to Plate Air Heaters and like Heat Exchangers.

We, JOHN EARLE WATSON and VARNUM SMITH LEWIS, both Citizens of the United States of America, of 9, Liberty Avenue, and 240, Drake Avenue, respectively, both in New Rochelle, Westchester County, State of New York, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to plate air heaters and like heat exchangers of the type in which a heating fluid at a relatively high temperature and a heat-receiving fluid at a relatively lower temperature are broken up into a number of thin streams by being passed through a number of narrow passages, in such a way that the passages traversed by the hotter or heating fluid alternate with the passages traversed by the cooler or heated fluid, the said passages being separated from one another by side plates or the like heat-transmitting walls.

The passages or channels through which the heating and heat receiving fluids pass are thus in intimate contact and in order to prevent a leakage and intermingling of the fluids, a tight or fluid proof joint must be provided for each set of fluid channels. Owing to the varying expansions and contractions of the metal of which the fluid separating walls are made, the provision and maintenance of fluid tight joints has heretofore presented considerable difficulty.

The object of our invention is to provide an improved heat exchanger of the above type in which tight joints may be simply and easily formed and maintained and in which the joints or seams in the fluid chambers may be easily and readily tightened.

The improved heat exchanger according to the invention comprises side plates, channel irons spanning and overlapping the side edges of the adjacent plates, and freely expansible means for spreading the edge portions of said plates and compressing them against the overlapping parts of said channel irons.

Various embodiments of the invention are illustrated in the accompanying drawings, in which

[Price 1/-]

Fig. 1 is a perspective view, partly in section, of a heat exchanger embodying a preferred form of the invention.

Figs. 2, 3 and 4 are, respectively, a plan, side and front elevation of a channel for the heat-receiving fluid of the heat exchanger.

Figs. 5, 6 and 7 are, respectively, plan, side and front elevations of the heating fluid channel of the heat exchanger.

Fig. 8 is a detailed side elevation of a closure or joint used in the heat receiving and heating channels of the heat exchanger.

Fig. 9 is a cross sectional view of the closure shown in Fig. 8 taken on line 9—9 of Fig. 8.

Figs. 10—18, inclusive, are similar sectional views of alternative forms of closures embodying our invention.

In the accompanying drawings our invention is illustrated as applied to a heat exchanger for transferring heat from a hot gas such as an exhaust flue gas to a current of air for example, the air to be supplied to a furnace. In this form of the invention the hot flue gases are conducted to the lower end of the exchanger 20 by means of a flue 21, and leave the upper part of the heat exchanger through an exhaust or outlet flue 22. The cold air to be heated in the exchanger enters the upper side part of the exchanger through an inlet conduit 23 and the heated air is withdrawn through an outlet conduit 24 at the lower portion of a side wall of the exchanger.

In the embodiment shown by way of example in Fig. 1, the air flues 23 and 24 enter and leave the same side of the heat exchanger, the inlet flue 23 entering throughout approximately the upper third of the area of the side of the heat exchanger and the flue 24 connecting to the lowest third of the area of the heat exchanger. Other alternatives may, however, be employed within the scope of our invention.

As the heating or flue gas enters the heat exchanger 20 it is divided into thin streams and passes through a number of

closely spaced, narrow, vertical passages 25 as indicated in Figs. 1 and 5, which are formed between spaced vertical plates 26 and 27 and are closed at their side edges by means of angle irons 28 and 29. As indicated in Figs. 8—18, these angle irons comprise a web 30 that spans the distance between the plates 26 and 27 and the thickness of the plates, and flanges 31 and 32 that overlap and enclose the side edges of the plates.

After passing through the passages 25 the exhaust flue gas leaves the apparatus through the flue 22. The air entering the apparatus through the inlet conduit or flue 23 is also divided into thin streams and enters sidewise into vertical passages 33 interspersed between the flue gas passages 25. The passages 33 are closed at their upper and lower ends by means of channel irons 34 and 35 similar in construction and arrangement to the channel irons 28 and 29 and arranged to overlap the plates 26 and 27 on the faces opposite those overlapped by the flanges 31 and 32 of the channel irons 28 and 29. Each of the plates 26 and 27 is thus connected at its top and bottom by means of channel irons extending to the next adjacent plate on one side, and at its side edges to the next adjacent plate on the opposite side or face of the plate. The side edges of the air passages opposite those at which the air enters and leaves are closed by means of a plate 36, as indicated in Fig. 6, and the opposite edges of the air passages 33 between the inlet and outlet flues 23 and 24 are closed by a narrower plate 37 so that the air entering the passages between the flue 23 passes in a reversely curved path downwardly through the air passages. The heat exchanger is enclosed in a framework comprising an upper angle iron rectangular frame 38, and a similar lower or bottom frame 39 to which the flues 22 and 21 are respectively connected, and of vertical posts 40 connecting the frames 38 and 39. The flues 23 and 24 may be attached to the side edges of the upper and lower frames 38 and 39 and the posts 40 and to cross bars 41.

It will be evident also that the channel irons 34 and 35 that enclose the air passages at their upper and lower ends serve to separate the air passages from the heating gas passages, and that the channel irons 28 and 29 that serve to enclose and form the heating gas channels also serve to separate them from the air inlet and outlet ducts or flues.

The joints formed between the overlapping channel flanges 31 and 32 and the plates 26 and 27 must be made air or fluid tight in order to prevent the mixing or commingling of the heating gas or fluid with the heat receiving gas or fluid. Inasmuch as the plates 26 and 27 and other parts of the heat exchanger are subjected to varying temperatures and degrees of heat as the apparatus is put into use, the joints between the channel irons and the plates must be tight at temperatures and variations in temperatures met with in common practice.

In our present invention this is accomplished by providing a joint structure in which the edge portions of the plates 26 and 27 are compressed against the flanges 31 and 32, and in which the pressure may be maintained at all temperature variations by maintenance or adjustment of the plates against the channel flanges. This is accomplished by spreaders between the edge portions of the plates 26 and 27 which may be expanded with a multiplied force or pressure by readily accessible means. These spreaders and expanders may have a wide variety of forms operated by means of bolts and nuts as illustrated in Figs. 9—17, in all of which the arrangement is such that the spreading motion is slight relatively to the tightening motion imparted by the bolt and nut.

In the form shown in Fig. 9 the expander comprises a pair of square bars 42, 43 that fill the space between the edge portions of the plates 26 and 27 up to about the edge of the flanges 31 and 32. The bars 42 and 43 are countersunk at their meeting faces at suitable intervals to receive the flaring head 44 of a stove bolt 45 which passes through an opening in the web 30 of the channel iron 29 and through a washer 46, and is drawn up tightly between the channel iron 29 and the bars 42 and 43 by means of a nut 47. It will be obvious that as the nut 47 is threaded tightly onto the bolt 45 it compresses the washer 46 tightly against the web 30, forming a tight joint about the stem of the bolt 45 and also wedges apart the square bars 42, 43, pressing them tightly against the plates 26 and 27 and compressing the latter tightly against the flanges 31, 32 of the channel iron 29.

In the form shown in Fig. 10, a curved plate 48 is compressed and flattened against the plates 26 and 27 by means of a bolt 49 which flattens the spreader plate 48 against a filler block 50.

The form of embodiment shown in Fig. 11 is similar to that of Fig. 10, except that in place of a filler block 50, a curved plate 51 reverse to the position of the plate 40 is employed.

In the form shown in Fig. 12 a curved spreader plate 48 is used, but the filler block 50 is omitted the edges of the plate

48 fitting directly against the edges of the plates 26 and 27 and the web 30 of the connecting channel iron.

The forms of embodiment shown in Figs. 13 and 14 are similar to those shown in Figs. 10 and 11, except that angular spreader plates 52 and 53 are used instead of the curved plates 48 and 51.

The form of embodiment shown in Fig. 15 is similar to that of Fig. 9, except that the spreader bars 42 and 43 are spread by means of a wedge-shaped nut 54 and a bolt 55.

In the form of embodiment shown in Fig. 16, a pair of small cylindrical tubes or bars 56 and 57 are placed in the corners between the plates 26 and 27 and the channel iron 29, and are wedged into these corners by means of a larger cylindrical pipe or bar 58 and a bolt 59 by which the pipe 58 is drawn towards the web of the channel iron.

In the embodiment shown in Fig. 17, the channel iron is provided with a re-entrant section 60 having a pair of upwardly and outwardly inclined walls 61 and 62 and a connecting web 63, the web 63 spanning the distance between the plates 26 and 27. The walls 61 and 62 are subjected to a compression stress by means of a bolt 64, there being a slight clearance between the stem of the bolt and the nearer edges of the walls 61. 62, so that as the nut is tightened on the bolt, the walls 61 and 62 are forced outwardly, thereby wedging them more tightly against the partition walls 26 and 27 and more tightly sealing the channel irons against the partition walls.

In the embodiment shown in Fig. 18 the plates 26 and 27 are offset inwardly as at 64 and 65, the offset edges being overlapped by the flanges 31 and 32 of the channel iron 29. In this way the outer surfaces of the flanges 31 and 32 may be made even with the outer surfaces of the plates 26 and 27.

The embodiment of Fig. 18 also illustrates the use of a wedge 66 instead of the nut 47 for drawing the spreading bolt against the web of the channel iron. A wedging bolt having the same type of head as in Fig. 9 is shown by way of example, but it will be understood that any of the other types of wedging devices may be employed with the wedge 66.

The nuts or tightening heads of the bolts are accessible from the exterior of the heat exchanger and, by tightening these bolts as the elements of the exchanger expand or contract, the air and gas passages may be maintained air or fluid tight. In the event that a leakage occurs, this may be readily corrected by tightening the respective bolts or nuts.

In the usual arrangement of heat exchangers the heating gases enter at the bottom or lower end of the exchanger corresponding to the inlet tube 21 in the accompanying drawings. In cases in which these flue gases are at or near a temperature at or near which the strength of the steel is very low, the weight of the upper part of the exchanger tends to cause the lower, hotter parts of the plates to buckle, causing deformation and warping unless a special and higher cost steel is employed.

In our invention, however, the weight of the plates of the heat exchanger may be supported by the clamped closure channels which, in turn, may be supported by attachment of said channels to the frame 38, 39 and 40 holding the assembly, or to an intermediate plate to said frame, thus avoiding having the entire weight of the assembly rest upon the bottom edge of the plates.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Improved heat exchanger of the kind referred to, comprising side plates, channel irons spanning and overlapping the side edges of adjacent plates, and freely expansible means for spreading the edge portions of said plates and compressing them against the overlapping parts of said channel irons.

2. Heat exchanger according to claim 1 in which the spreaders are expanded by means of an outwardly directed wedging action.

3. Heat exchanger according to claims 1 and 2, in which the wedging action is operated by means of bolts extending through the spreaders and tightened by means of nuts.

4. Heat exchanger according to claim 1 in which the side plates are compressed against the overlapping parts of the channel irons alternately at the top and bottom, and at the side edges of the plates.

5. Heat exchanger according to claims 1 to 3, in which the spreading and tightening devices are so arranged that the spreading motion is slight relatively to the tightening motion imparted by the bolt.

6. Heat exchanger according to claims 1 and 2, comprising a slightly curved spreader and means for flattening said curved spreader to wedge it against the side plates.

7. The improved heat exchanger according to claim 1 and to any of the claims

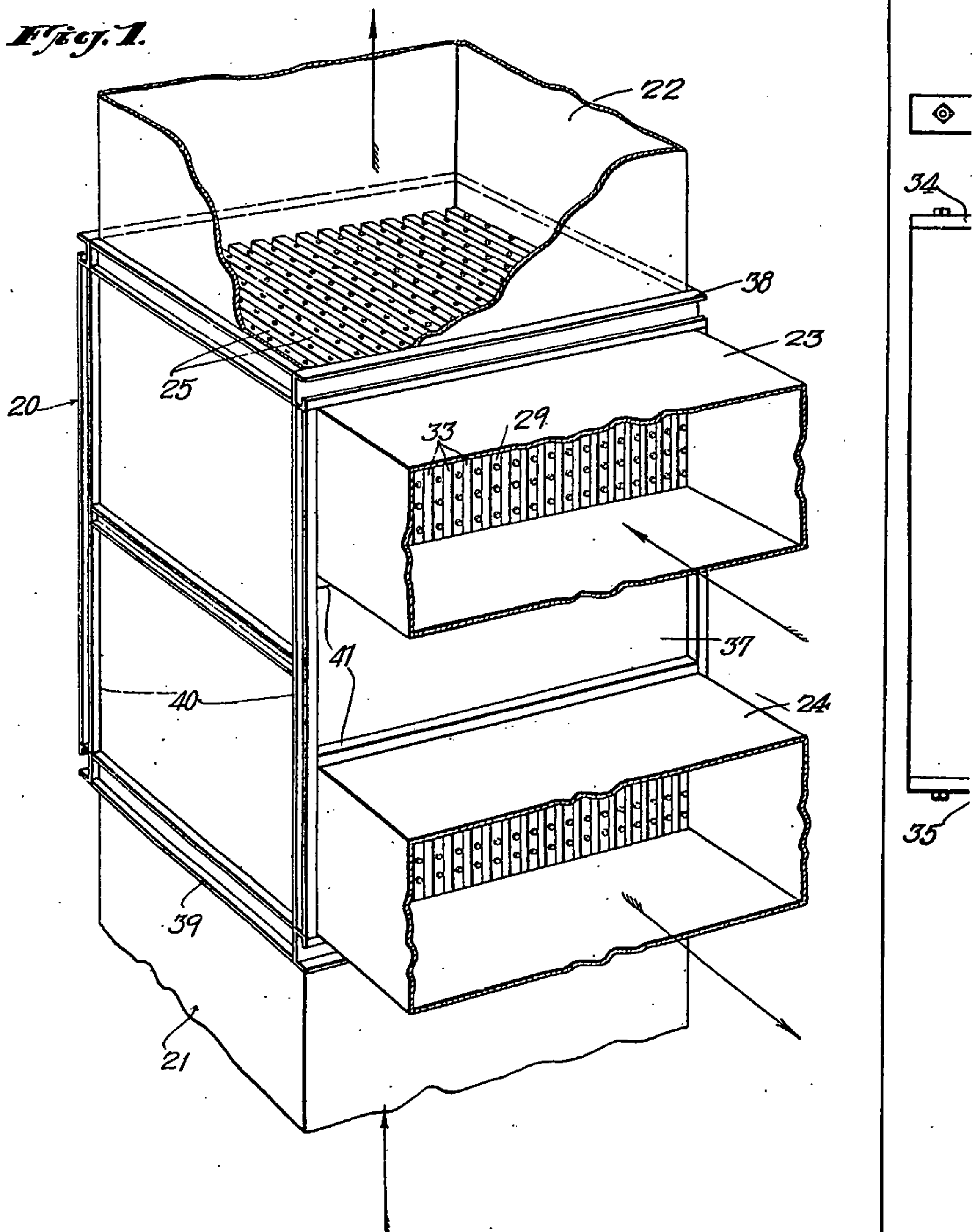
2 to 6, substantially as described and illustrated in the accompanying drawings.

Dated the 25th day of May, 1931.

MEWBURN, ELLIS & Co.,
70 & 72, Chancery Lane, London, W.C.2,
Chartered Patent Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1932.

Fig. 1.



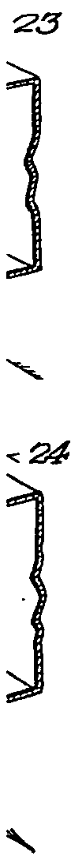


Fig. 2.

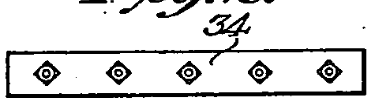


Fig. 5.

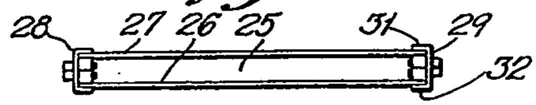


Fig. 3.

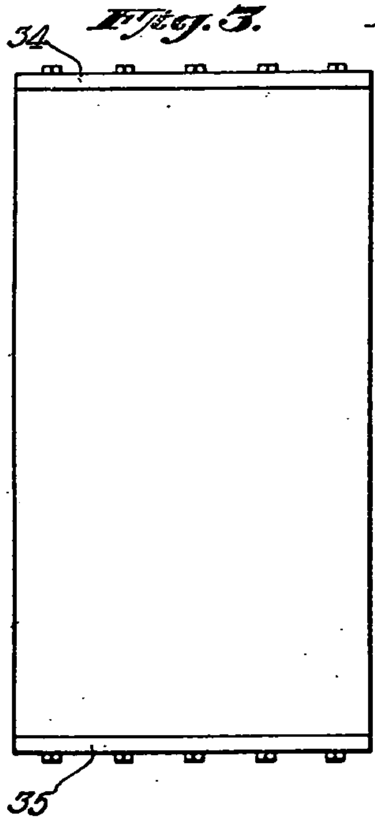


Fig. 4.

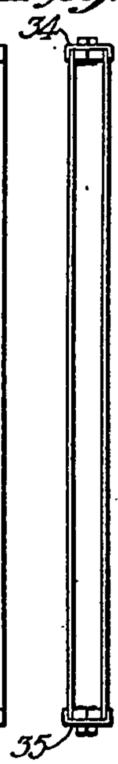


Fig. 6.

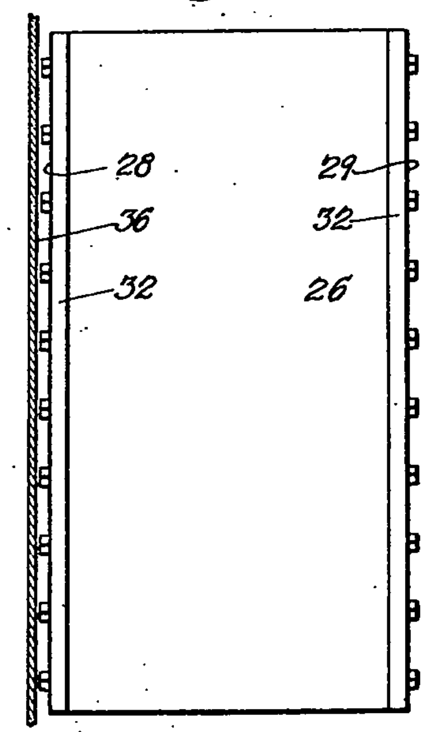


Fig. 7.

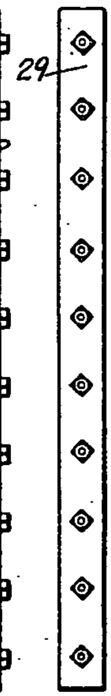
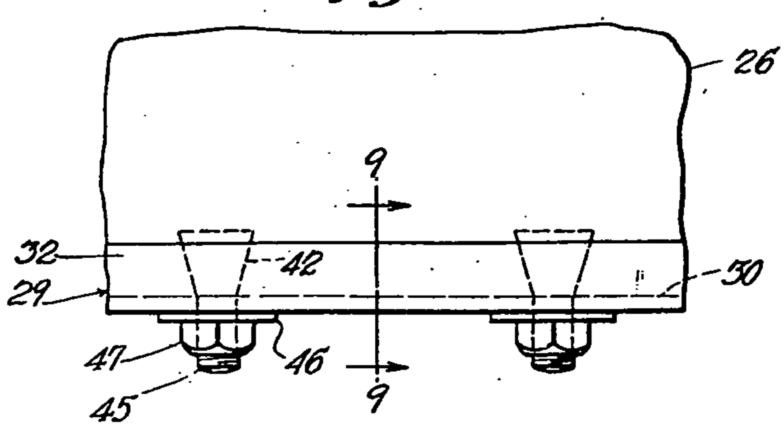


Fig. 8.



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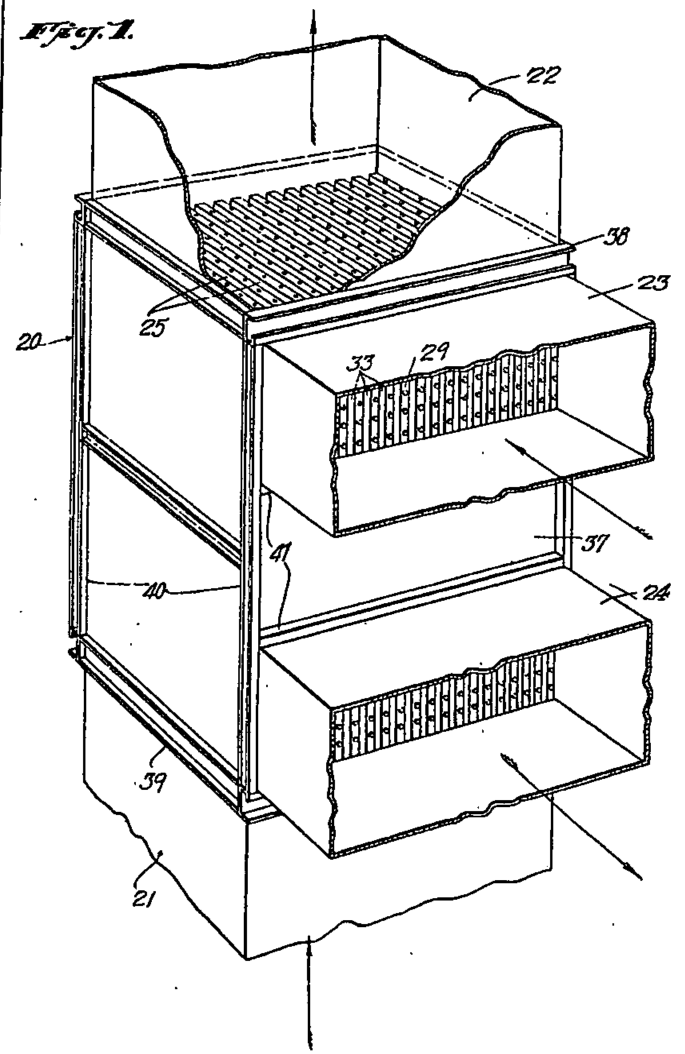
372,961 COMPLETE SPECIFICATION

3 SHEETS

SHEET 1

Fig. 1.



SHEET 2

Fig. 2.

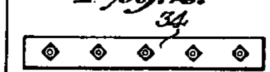


Fig. 5.

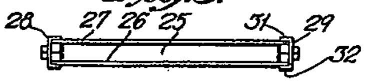


Fig. 3.

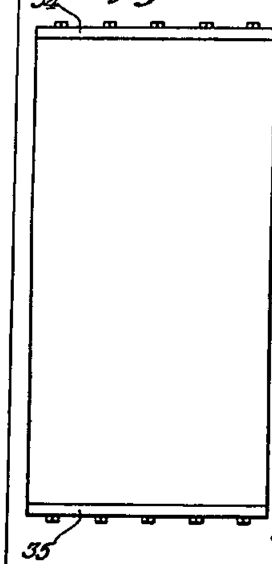


Fig. 4.

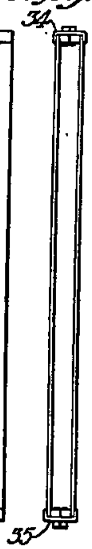


Fig. 6.

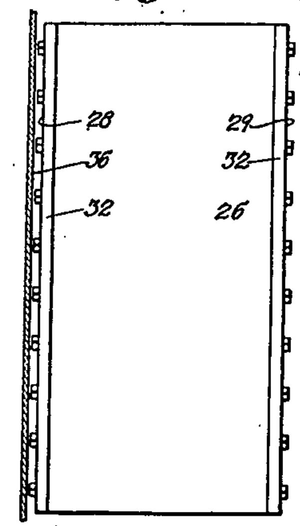


Fig. 7.

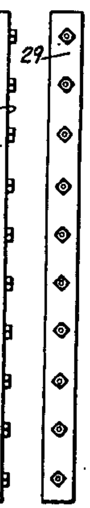


Fig. 8.

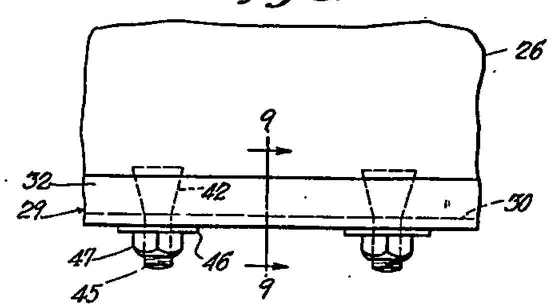


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Fig. 9.

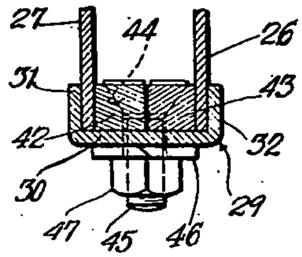


Fig. 10.

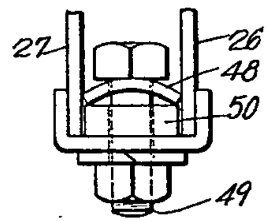


Fig. 11.

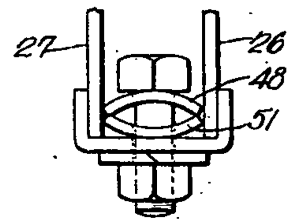


Fig. 12.

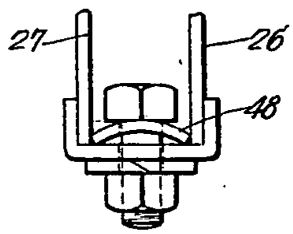
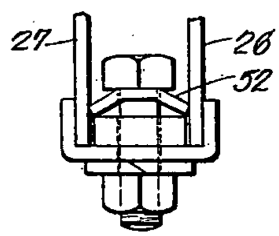


Fig. 13.



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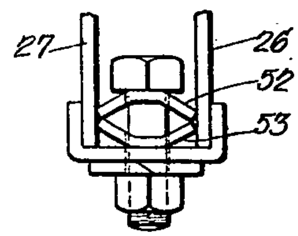

Fig. 15.

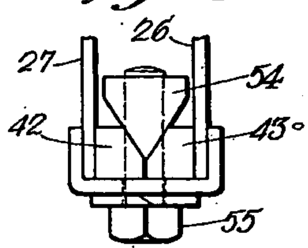

Fig. 16.

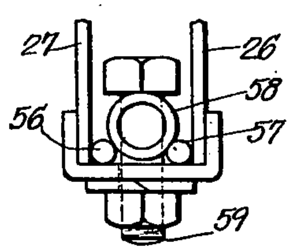

Fig. 17.

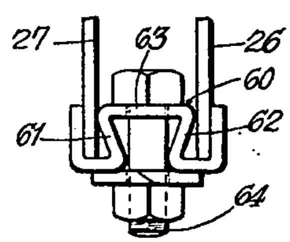

Fig. 18.